



ANALYTICS EXPERIENCE

The SAS Viya end-to-end Platform for Machine Learning and Artificial Intelligence in Action

Gerhard Svolba

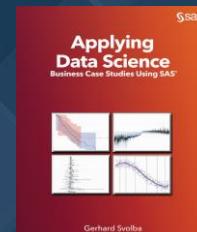
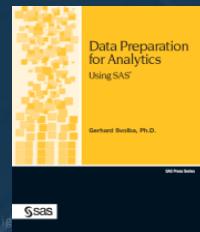
Analytic Solution Architect - SAS DACH

Milan, October 23rd, 2018



Most recent blog (LinkedIn)

*My Dad has the most interesting
job in the world.
He is a data scientist.*



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sas
®

Twitter: @gsvolba

The Rationale of this Presentation

- Machine Learning methods can generate recommendations for demand planners when and how to override forecasts (direction/amount)
- SAS Viya facilitates the handshake between different user personas in the analysis process.
- From a modeling point of view SAS Viya includes capabilities for Statistics, Machine Learning, Deep Learning, Time Series Forecasting, Optimization, and Text Analytics.
- Users can interact with SAS Viya by coding in different programming languages, using Visual interfaces or working with predefined analysis templates.

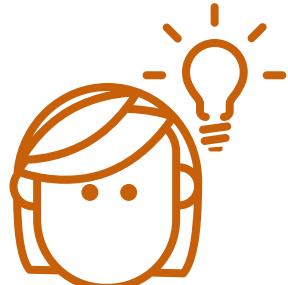
Business Background of the Case Study

- International company in the “Retail/Manufacturing” industry
- Demand forecasting on monthly basis
- Analysis of the forecast quality (statistical FC, manual FC/Override)
- Manual Overrides: Recommendation for direction and quantity
- Different persona groups are involved in the forecasting

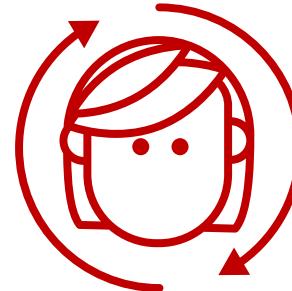
Different Persona Groups in our Case Study



Demand Planner



Demand Analyst



Data Scientist



IT / Automation

Available data and data preparation

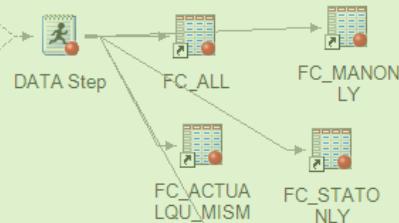
Statistical Forecast



Manual Override



Data Quality Check



Forecast Model
Lead Time
Target Year
Target Calendar Month

Product Group

Price

Launch Calendar Month

Product Age (=Data History)

Product Master Data



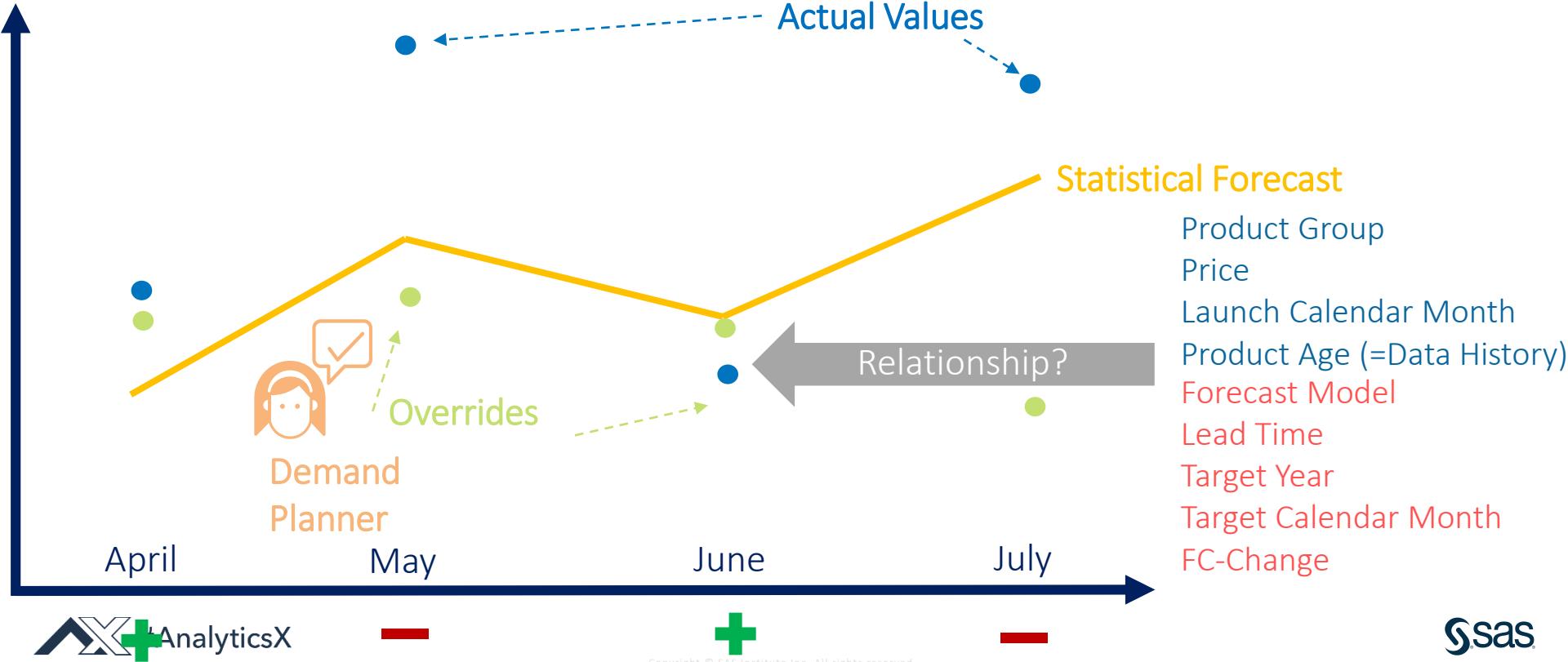
Calculating Derived Variables



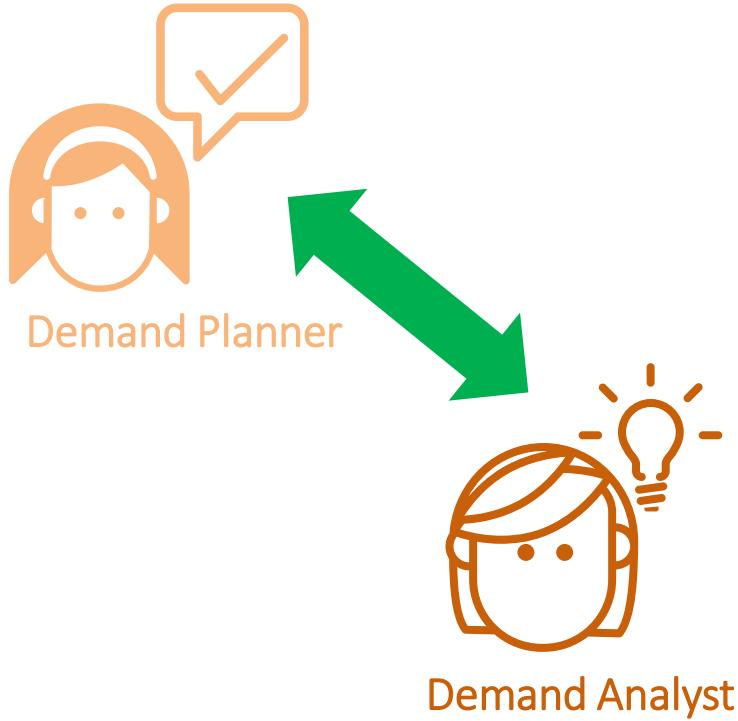
FVA (Forrecast Value Add) =
deviation statistical model
-deviation manual model

Changing Forecasts with Manual Overrides

Forecast for Item 1673: „GPS Tracker Waterproof“



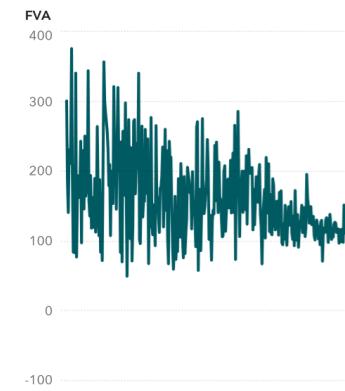
Creating an initial model from a business point of view



ee FVA_Ind (event=1)
ns Used 423,347



FVA by FC_Change10Cat



FVA_Ind
0 1

FC_Review_V2



Data

FC REVIEW

FVA FVA_Ind FVA_Diff_Means Box_Age Tree_Simple Tree_Large ClusterAnalysis



Objects

Search



+ New data item

- FVA
- ID
- Judgm_FC
- Launch_Month
- Launch_Year
- Lead_Time
- Price_Index
- Product_Age
- Product_Group
- Stat_FC
- Target_Year

Frequency of FVA

Frequency

60,000

40,000

20,000

0

-400

-200

0

200

FVA



FC_Review_V2



Data

FC REVIEW

FVA FVA_Ind FVA_Diff_Means Box_Age Tree_Simple Tree_Large ClusterAnalysis

Objects

Outline

Search

FVA by FC_Change10Cat

FVA

400

300

200

100

00

0

00

0

00

0

00

0

00

0

00

0

00

0

00

0

00

0

00

0

00

0

00

0

00

Benefit

Error +

DECREASE FC

INCREASE FC

FC_Change10Cat



New data item

Create_CalMonth - 12

Create_Month - 84

FC_Change10Cat - 1K

FVA_Ind - 2

Model - 5

Partition - 2

Target_CalMonth - 12

Target_Month - 84

Measure

Actual

APE_Judgm_shift

#AnalyticsSA

SAS

FC_Review_V2



Data

FC REVIEW



FVA

FVA_Ind



FVA_Diff_Means

Box_Age

Tree_Simple

Tree_Large

ClusterAnalysis



Objects

Outline

Search



+ New data item

Create_CalMonth - 12

Create_Month - 84

FC_Change10Cat - 1K

FVA_Ind - 2

Model - 5

Partition - 2

Target_CalMonth - 12

Target_Month - 84

▼ Measure

Actual

APE_Judgm_shift

Frequency of FVA_Ind

Name:

FVA_Ind

Result Type:

Numeric

Data Items

Operators

Visual

Text

Search



▼ Boolean

AND

IF...ELSE

NOT

OR

```
IF ( FVA > 0 )  
  RETURN 1  
ELSE 0
```

FC_Review_V2



Objects



Search

▼ Graphs

Bar Chart

Box Plot

Bubble Change Plot

Bubble Plot

Butterfly Chart

Comparative Time Series Plot

Correlation Matrix

Dot Plot

Dual Axis Bar Chart

Dual Axis Bar-Line Chart

Dual Axis Line Chart

Dual Axis Time Series Plot

Gauge

FVA

FVA_Ind

FVA_Diff_Means

Box_Age

Tree_Simple

Tree_Large

ClusterAnalysis



Product_Age by FVA_Ind

Product_Age

125

100

75

50

25

0



0

1

FVA_Ind

Product_Age Product_Age

FC_Review_V2



Objects

Search



▼ SAS Visual Statistics

-  Cluster
-  Decision Tree
-  Generalized Additive Model
-  Generalized Linear Model
-  Linear Regression
-  Logistic Regression
-  Model Comparison
-  Nonparametric Logistic Regress...

▼ SAS Visual Data Mining and Machine ...

-  Factorization Machine
-  Forest
-  Gradient Boosting

FVA_Ind	FVA_Diff_Means	Box_Age	Tree_Simple		
---------	----------------	---------	-------------	---	---

Tree_Simple

Data Roles

Decision Tree 1

▼ Response

 FVA_Ind

▼ Predictors

-  Target_CalMonth
-  FC_Change
-  Product_Age
-  Add

▼ Partition ID

 Add

FC_Review_V2



Objects

Search



▼ SAS Visual Statistics

Cluster

Decision Tree

Generalized Additive Model

Generalized Linear Model

Linear Regression

Logistic Regression

Model Comparison

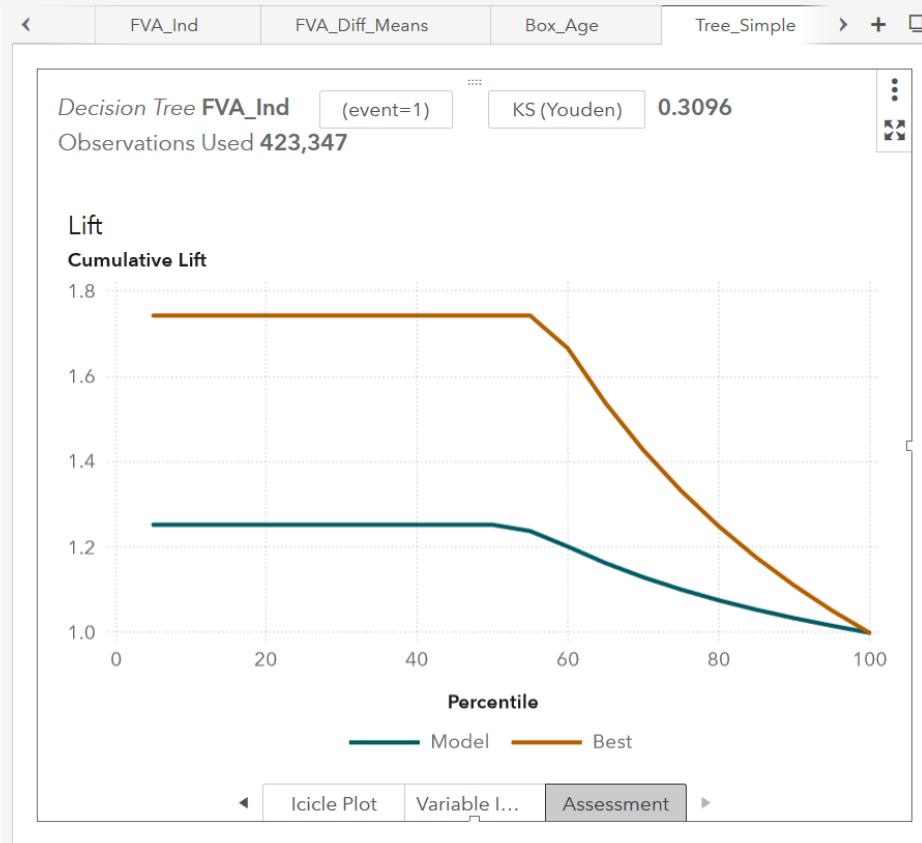
Nonparametric Logistic Regress...

▼ SAS Visual Data Mining and Machine ...

Factorization Machine

Forest

Gradient Boosting



Data Roles

Decision Tree 1

▼ Response

FVA_Ind

▼ Predictors

Target_CalMonth

FC_Change

Product_Age

+ Add

▼ Partition ID

+ Add

FC_Review_V2

 Data Objects Outline New

Objects

Search 

▼ SAS Visual Statistics

-  Cluster
-  Decision Tree
-  Generalized Additive Model
-  Generalized Linear Model
-  Linear Regression
-  Logistic Regression
-  Model Comparison
-  Nonparametric Logistic Regress...

▼ SAS Visual Data Mining and Machine ...

-  Factorization Machine
-  Forest
-  Gradient Boosting

« Box_Age Tree_Simple Tree_Large ⋮ ClusterAnalysis » + □

Data Roles

Decision Tree 1 (1) 

▼ Response

 FVA_Ind

▼ Predictors

-  Target_CalMonth
-  FC_Change
-  Product_Age
-  Model
-  Product_Group
-  Price_Index
-  Lead_Time
-  Add

▼ Partition ID

 Add

FC_Review_V2



Objects

Search



SAS Visual Statistics

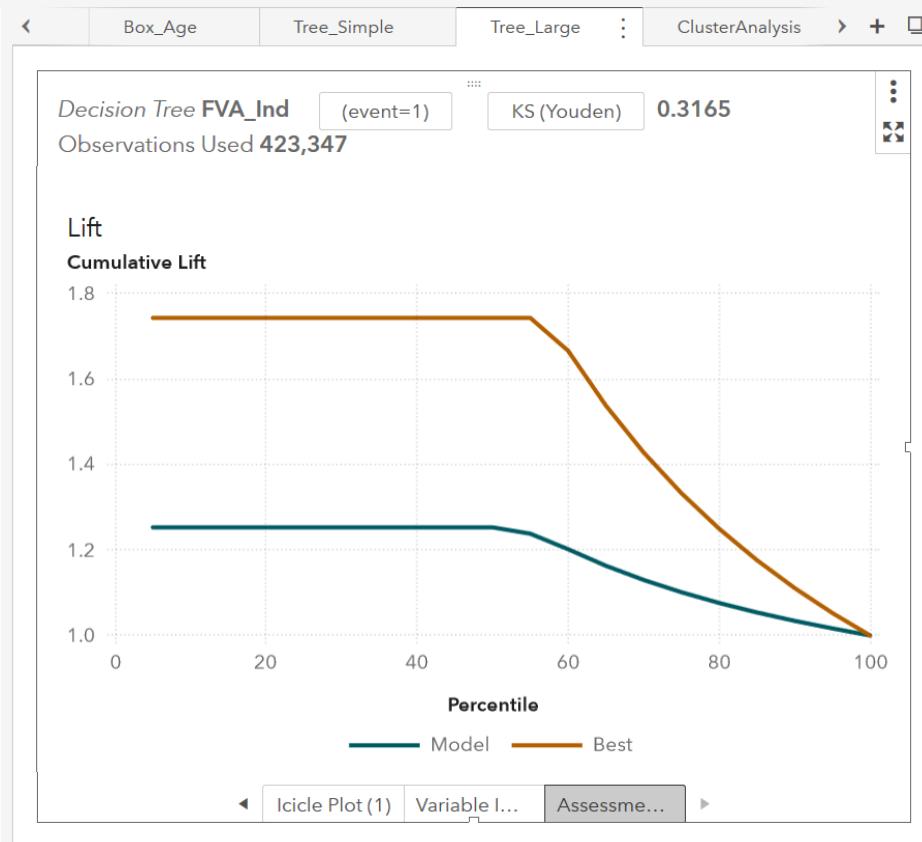
- Cluster
- Decision Tree
- Generalized Additive Model
- Generalized Linear Model
- Linear Regression
- Logistic Regression
- Model Comparison
- Nonparametric Logistic Regress...

SAS Visual Data Mining and Machine ...

- Factorization Machine
- Forest
- Gradient Boosting



#AnalyticsSA



Data Roles

Decision Tree 1 (1)

Response

FVA_Ind

Predictors

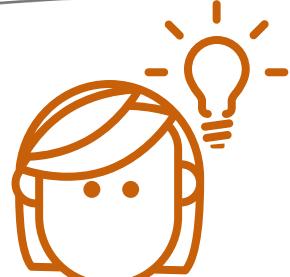
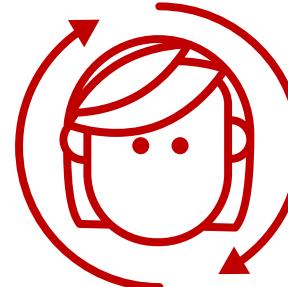
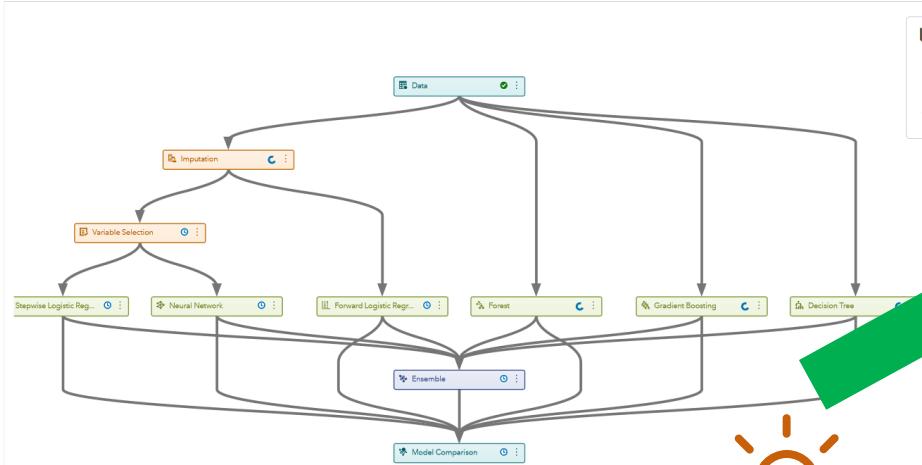
- Target_CalMonth
- FC_Change
- Product_Age
- Model
- Product_Group
- Price_Index
- Lead_Time
- Add

Partition ID

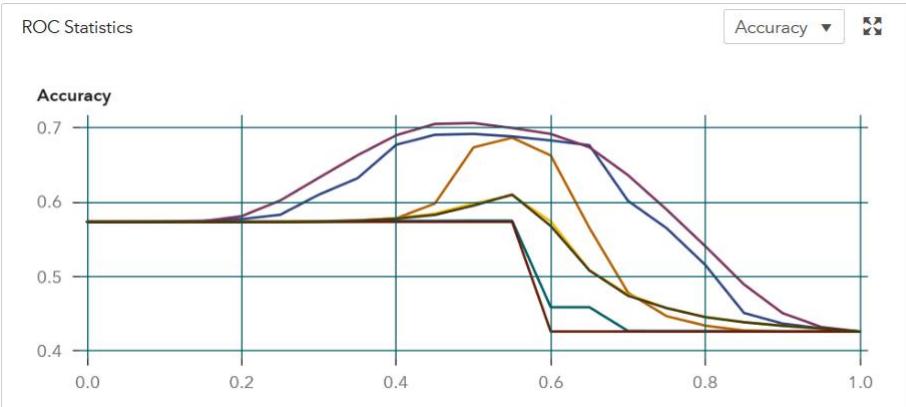
Add



Refining the Model



Demand Analyst



FC_Review_V2



Objects

Search



SAS Visual Statistics

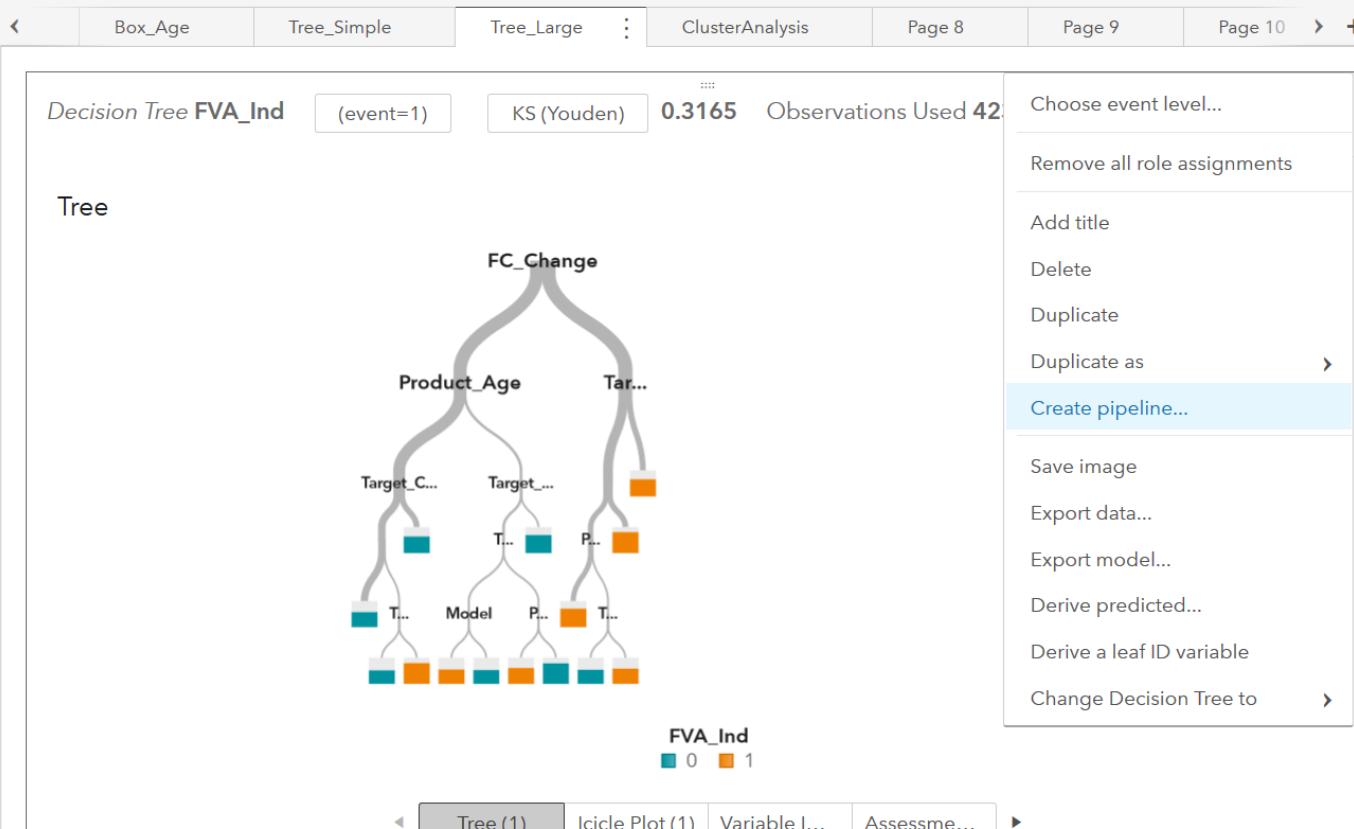
- Cluster
- Decision Tree
- Generalized Additive Model
- Generalized Linear Model
- Linear Regression
- Logistic Regression
- Model Comparison
- Nonparametric Logistic Regress...

SAS Visual Data Mining and Machine ...

- Factorization Machine
- Forest
- Gradient Boosting



#AnalyticsX



FC_Review_V2 (2)

Data

Pipelines

Pipeline Comparison

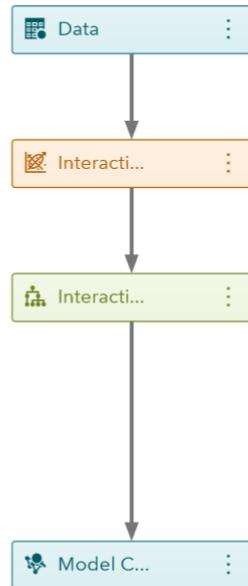


Nodes



- ▶ Data Mining Preprocessing
- ▶ Supervised Learning
- ▶ Postprocessing
- ▶ Miscellaneous

Pipeline from Interactive Model



Data



Description:

Defines all the information about the data set.

FC_Review_V2 (2)



Data

Pipelines

Pipeline Comparison



Nodes



Data Mining Preprocessing

Anomaly Detection

Clustering

Feature Extraction

Filtering

Imputation

Manage Variables

Replacement

Text Mining

Transformations

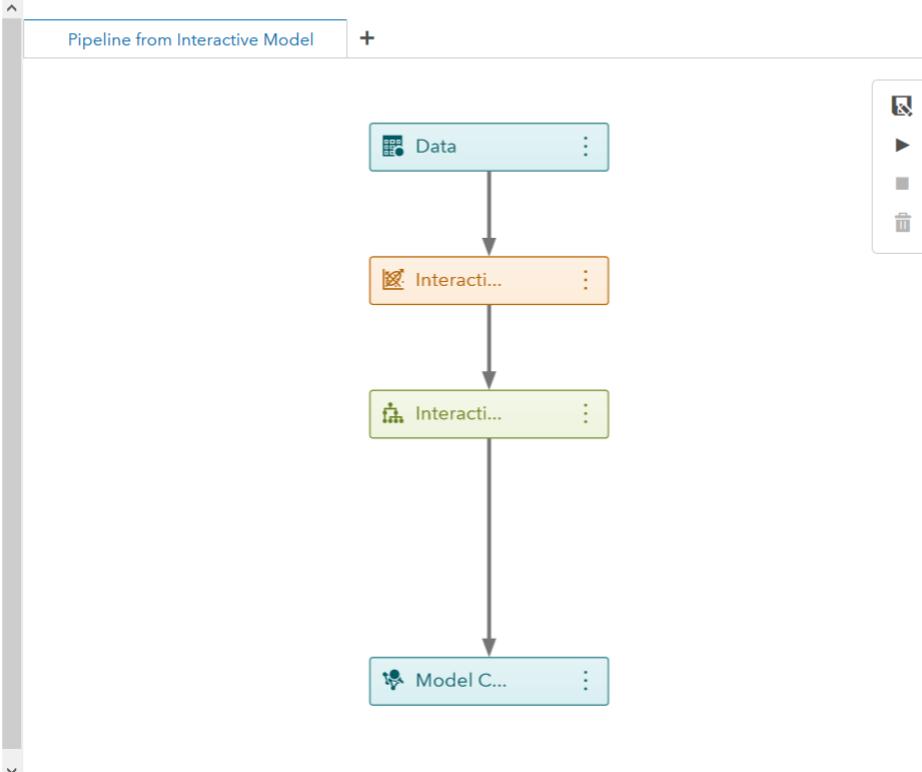
Variable Clustering

Variable Selection

Supervised Learning

Postprocessing

Miscellaneous



Data



Description:

Defines all the information about the data set.

FC_Review_V2 (2)



Data

Pipelines

Pipeline Comparison



Nodes

Replacement

Text Mining

Transformations

Variable Clustering

Variable Selection

Supervised Learning

Bayesian Network

Decision Tree

Forest

GLM

Gradient Boosting

Linear Regression

Logistic Regression

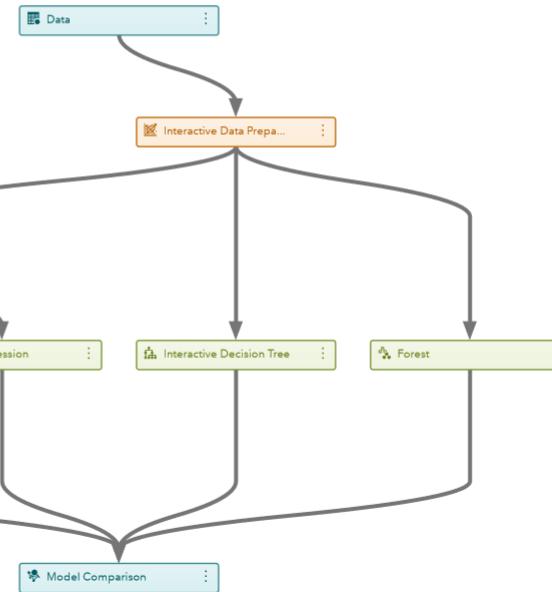
Neural Network

SVM

Postprocessing

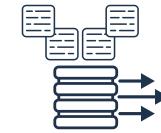
Miscellaneous

Pipeline from Interactive Model



Options

SAS Viya offers a Broad Range of Analytical Capabilities



Data Manipulation

- In-Memory Data Step
- Frequency / Crosstab
- Data Transpose
- Variable Binning
- Variable Cardinality Analysis
- Variable Summary
- Sampling and Partitioning
- Missing Value Imputation
- Variable Selection
- Model Assessment
- DS2
- FedSQL

Statistics

- Cox Proportional Hazards
- Decision Trees
- Design Matrix
- General Additive Models
- Generalized Linear Models
- K-means and K-modes Clustering
- Linear Regression
- Logistic Regression
- Nonlinear Regression
- Ordinary Least Squares Regression
- Partial Least Squares Regression
- Pearson Correlation
- Principal Component Analysis
- Quantile Regression
- Shewhart Control Chart Analysis

Machine Learning

- Bayesian Networks
- Boolean Rules
- Factorization Machines
- Frequent Item Set Mining
- Gradient Boosting
- K Nearest Neighbor
- Image Processing
- Market Basket Analysis
- Moving Windows PCA
- Network Analytics/Community Detection
- Neural Networks / Deep Learning
- Random Forest
- Robust PCA
- Support Vector Data Description
- Support Vector Machines
- Text Mining
- Variable Clustering

FC_Rev1

Data

Pip



Nodes

Filter

Browse Templates

Filter

Template Name	Description	Owner	Last Modified
Advanced template for class target with autotuning	Advanced template for class target with autotuned tree, forest, neural network and gradient boosting models.	SAS Pipeline	Feb 2, 2018, 7:41:36 PM
Advanced template for class target	Extends the intermediate template for class target with neural network, forest, and gradient boosting models, as well as an ensemble.	SAS Pipeline	Feb 2, 2018, 7:41:58 PM
Advanced template for interval target with autotuning	Advanced template for interval target with autotuned tree, forest, neural network and gradient boosting models.	SAS Pipeline	Feb 2, 2018, 7:42:22 PM
Advanced template for interval target	Extends the intermediate template for interval target with neural network, forest, and gradient boosting models, as well as an ensemble.	SAS Pipeline	Feb 2, 2018, 7:42:41 PM
Basic template for class target	A simple linear flow: Data, Transformations, Imputation, Logistic Regression, Model Comparison.	SAS Pipeline	Feb 2, 2018, 7:43:02 PM
Basic template for interval target	A simple linear flow: Data, Transformations, Imputation, Linear Regression, Model Comparison.	SAS Pipeline	Feb 2, 2018, 7:43:10 PM
Blank Template	A Data Mining pipeline that contains only a data	SAS Pipeline	Feb 2, 2018,

OK

Cancel

FC_Review_V2 (2)

Data Pipelines Pipeline Comparison



Nodes



Data Mining Preprocessing

Supervised Learning

Postprocessing

Ensemble

Miscellaneous

Code

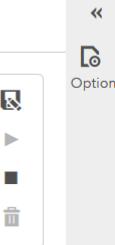
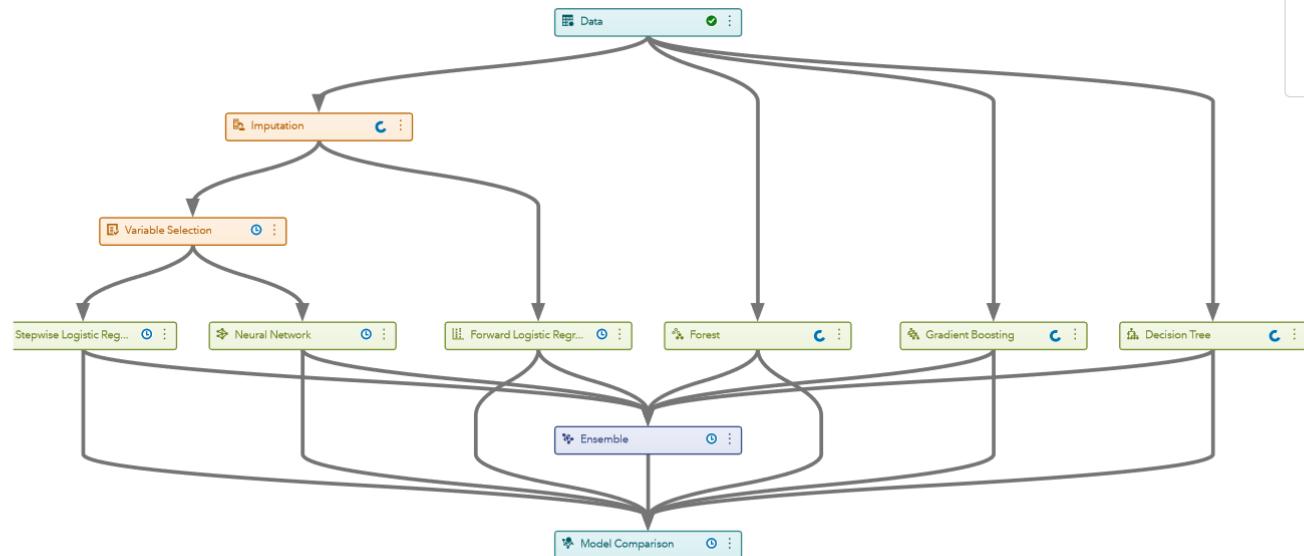
Data Exploration

Save Data



Pipeline from Interactive Model

Pipeline_Template

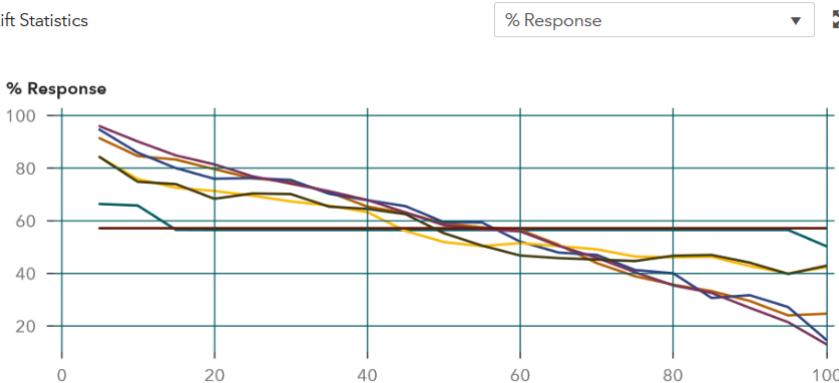


FC Review V2 (2) > Model Comparison Results

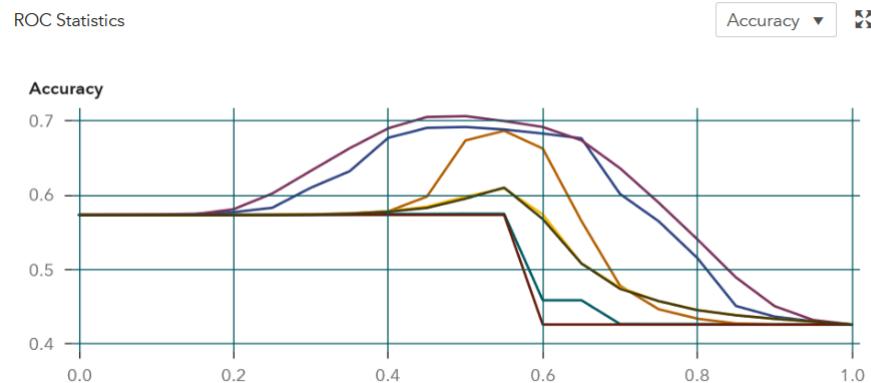
Close

Champion	Name	Algorithm Name	KS (Youden)	Misclassification Rate
Gradient Boosting	Gradient Boosting	Gradient Boosting	0.3938	0.2938
Forest	Forest	Forest	0.3716	0.3083
Ensemble	Ensemble	Ensemble	0.3621	0.3264
Forward Logistic Regression	Logistic Regression	Logistic Regression	0.2067	0.4019
Stepwise Logistic Regression	Logistic Regression	Logistic Regression	0.2004	0.4045
Decision Tree	Decision Tree	Decision Tree	0.0366	0.4248
Neural Network	Neural Network	Neural Network	0	0.4264

Lift Statistics



ROC Statistics



FC_Review_V2 (2)

Data Pipelines Pipeline Comparison



Nodes



Data Mining Preprocessing

Supervised Learning

Postprocessing

Ensemble

Miscellaneous

Code

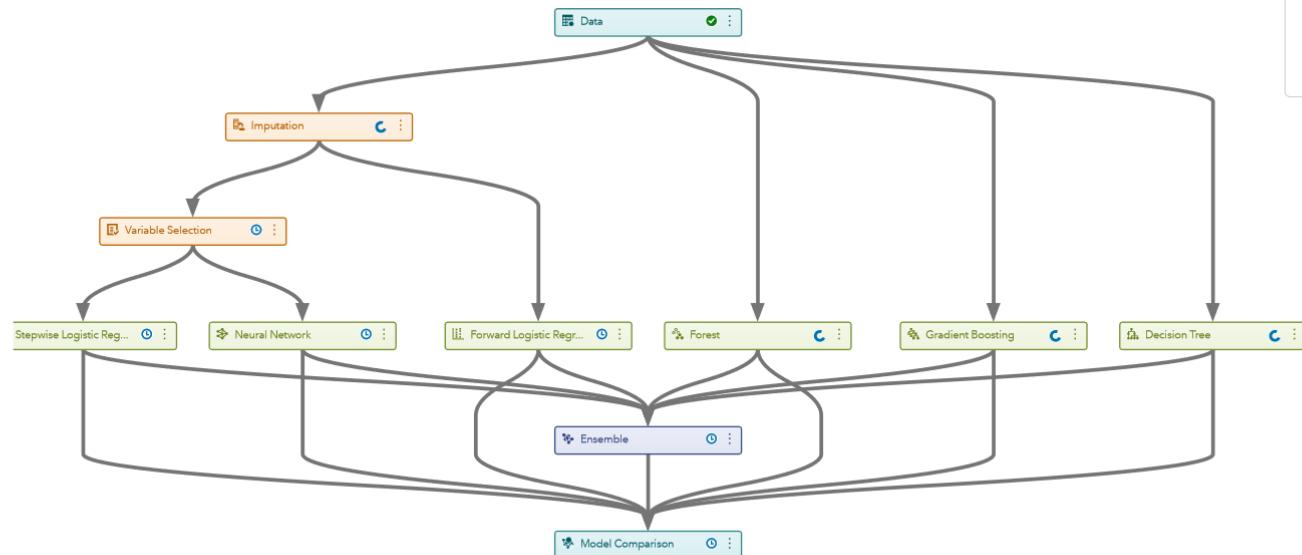
Data Exploration

Save Data



Pipeline from Interactive Model

Pipeline_Template



FC_Review_V2 (2)



Data

Pipelines

Pipeline Comparison



Filter



Compare



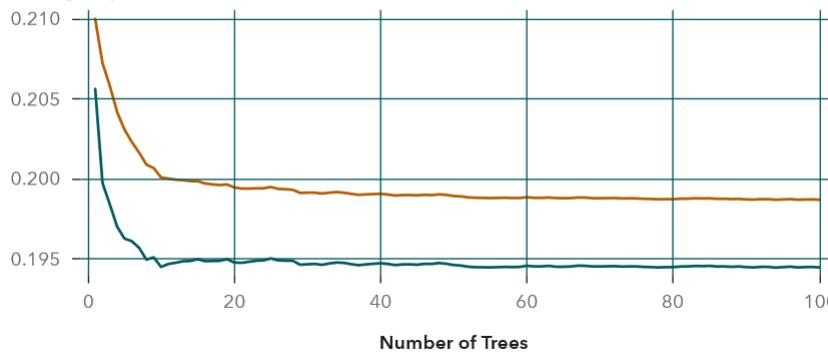
<input type="checkbox"/>	Champion	Name	Algorithm Name	Pipeline Name	KS (Yodice E:
<input checked="" type="checkbox"/>		Gradient Boosting	Gradient Boosting	Pipeline_Template	0.394
<input type="checkbox"/>		Forest	Forest	Pipeline from Interactive Model	0.396

Error Plot

Average Squared Error ▾



Average Squared Error



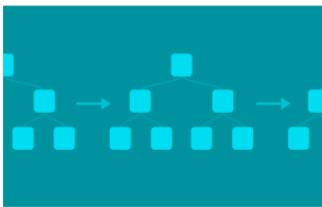
Variable Importance



Variable Name	Train Importance	Importance Stan...	Relative Importa...
FC_Change	12,880.1050	681.3640	1
_va_d_Target_Cal	3,427.5366	27.2514	0.2661
Month_ONES			
Product_Age	2,008.0879	22.6519	0.1559
Price_Index	1,946.8176	10.3107	0.1511
Product_Group	1,463.8939	14.3354	0.1137
Lead_Time	1,047.9979	3.1709	0.0814
Model	962.0411	28.9383	0.0747

Projects

Search

 FC_Review_V2 (2)

Date modified: Jun 17, 2018, 4:47:20 PM

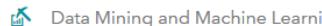
Created by: sasdemo01

Modified by: sasdemo01

Data source: CASUSER_VA_FC_REV...

Shared with: Private

Champion mo... Gradient Boosting



New Project

New Project



Name: *

Project 2

Type: *

Data Mining and Machine Learning

Data Mining and Machine Learning

Forecasting

Text Analytics

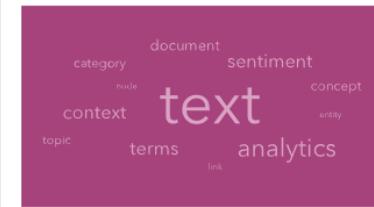
Description:

Enter description

 Partition data Event-based sampling

Save

Cancel

 Nike Shoes

Date modified: May 16, 2018, 3:10:12...

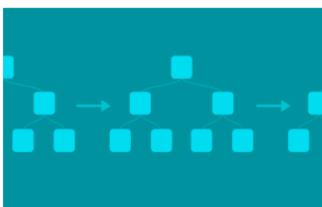
Created by: sasdemo01

Modified by: sasdemo01

Data source: Public.NIKE2SHOESRAW

Shared with: Private

Language: English

 New_Product_V1_ph

Date modified: May 16, 2018, 12:06:40...

 New_Product_V2

Date modified: May 16, 2018, 11:59:28...



sas

Getting the Model Into Production

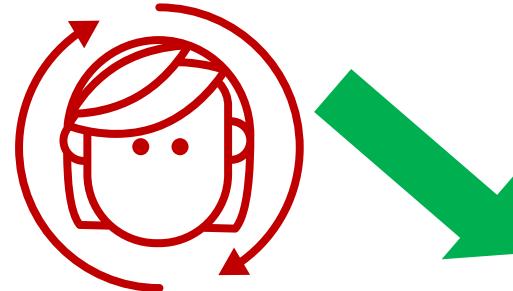
Scoring API

Scoring API:

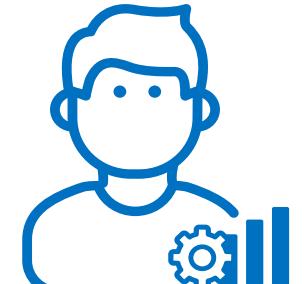
```
POST /dataMining/projects/44582f1e-16d7-40d1-a5e4-8836dd35e511/models/a352ed7-675d-43d9-a9dc-f5db8b5bb18d/scoreExecutions
Accept: application/vnd.sas.score.execution+json
Content-Type: application/vnd.sas.analytics.data.mining.model.score.request+json
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  "outputCasLibraryName": "",
  "outputTableName": ""
}
Authorization: bearer
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UzZWENdyWOC1tYyRILWU3NtC1Ndq12jA1MclsnNb38ljpblmWzVsPzClsm1hcmtdgluzylsnBLU0FkbVluaxXN0cmF0b3JzJ0smNsawWudF9zC6lnNhoySkYXRhTWfusW5
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0251InJ3NTQ4NWYwNTALC_llerHrfaWQjO1uAWOp2FzZGvbaAsLg91PXvZxJzGRjPXZpewMExMykYz1jb20lCjvcmnlaW4jOlzZGfawlidKNCi9yUW1ljipoc2FzZGvbaAxliw
iZW1haWw0OlzjYXNkZW1wMDFAZGfjaC12aXhMaMtc21wLnzpeWEzMyzjYXMuZy29liwcmV2X3NpZyj6j0MTA1OTUjwiaWF0joxNT5MjQ20TA5LjleHAjOjE1MjlyOTAMD
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2hr6FDJxBFDvQPYETn710E7NYtMG50a4HGSSPbeUwAVdfw5gJtsIfNdyWrtJnEv-yPhtUheze0
```

Download Type:

REST
SAS
Python
REST



Data Scientist



IT / Automation

Models					Variables	Properties	Tests	Performance	Workflow	History
Filter		Version: Version 1 (1.0)								
	Name	Model Function	Project Version	Algorithm	Date Modified					
<input checked="" type="checkbox"/>	Forest (Pipeline from Inter...)	Classification	Version 1 (1.0)	Forest	Jun 17, 2018 04:47 PM					
<input checked="" type="checkbox"/>	Gradient Boosting (Pipel...)	Classification	Version 1 (1.0)	Gradient boosting	Jun 17, 2018 04:46 PM					

FC_Review_V2 (2)



Data

Pipelines

Pipeline Comparison



Filter



Compare



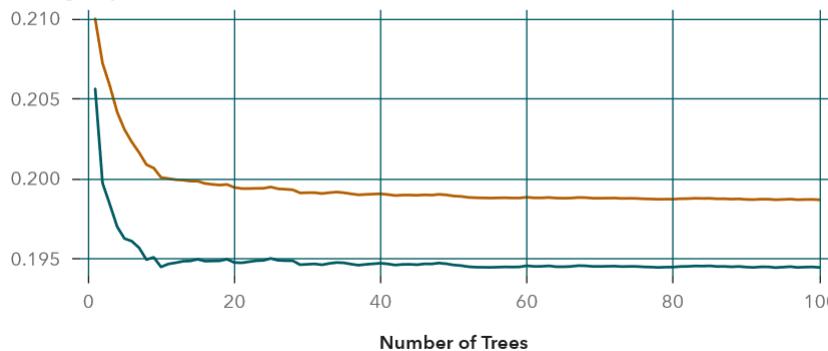
<input type="checkbox"/>	Champion	Name	Algorithm Name	Pipeline Name	KS (Yodice E:
<input checked="" type="checkbox"/>		Gradient Boosting	Gradient Boosting	Pipeline_Template	0.394
<input type="checkbox"/>		Forest	Forest	Pipeline from Interactive Model	0.396

Error Plot

Average Squared Error ▾



Average Squared Error



Variable Importance



Variable Name	Train Importance	Importance Stan...	Relative Importa...
FC_Change	12,880.1050	681.3640	1
_va_d_Target_Cal	3,427.5366	27.2514	0.2661
Month_ONES			
Product_Age	2,008.0879	22.6519	0.1559
Price_Index	1,946.8176	10.3107	0.1511
Product_Group	1,463.8939	14.3354	0.1137
Lead_Time	1,047.9979	3.1709	0.0814
Model	962.0411	28.9383	0.0747

FC_Review_V2 (2)

Data Pipelines Pipeline Comparison

Filter

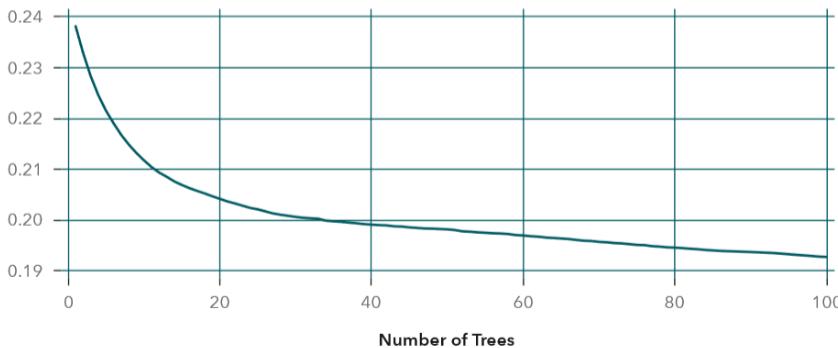
Compare



<input type="checkbox"/> Champion	Name	Algorithm Name	Pipeline Name
<input checked="" type="checkbox"/> 	Gradient Boosting	Gradient Boosting	Pipeline_Template
<input type="checkbox"/>	Forest	Forest	Pipeline from Interactive Model

Error Plot

Average Squared Error ▾



Variable Importance

Variable Name	Train Importance	Importance Stand...
FC_Change	598.7530	705.4706
Create_Month	164.1219	31.9011
Launch_Month	120.4500	19.8545
Product_Group	110.5931	20.8723
Create_CalMonth	86.3525	13.2233
Price_Index	71.7160	13.7345
Product_Age	64.0715	31.5222
Lead_Time	55.6667	7.8584
		0.0930

Score Inputs



Score Outputs



SAS® Model Manager - Manage Models

FC_Review_V2 (2)

Search

SAS Demo User 01

Models Variables Properties Tests Performance Workflow History

Filter Version: Version 1 (1.0) New Model Import Compare

Name	Model Function	Project Version	Algorithm	Date Modified	Modified By
Forest (Pipeline from Inter...)	Classification	Version 1 (1.0)	Forest	Jun 17, 2018 04:47 PM	sasdemo01
Gradient Boosting (Pipeli...)	Classification	Version 1 (1.0)	Gradient boosting	Jun 17, 2018 04:46 PM	sasdemo01

FC_Review_V2 (2)

Data Pipelines Pipeline Comparison

Filter

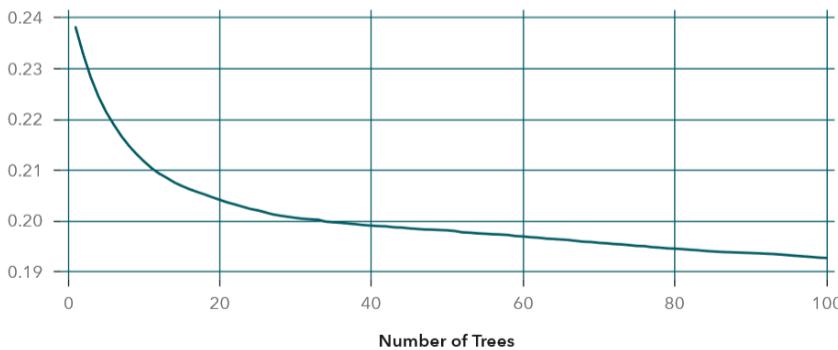
Compare



<input type="checkbox"/> Champion	Name	Algorithm Name	Pipeline Name
<input checked="" type="checkbox"/>	Gradient Boosting	Gradient Boosting	Pipeline_Template
<input type="checkbox"/>	Forest	Forest	Pipeline from Interactive Model

Error Plot

Average Squared Error ▾



Variable Importance

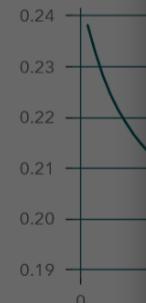
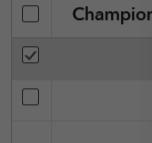
Variable Name	Train Importance	Importance Stand...
FC_Change	598.7530	705.4706
Create_Month	164.1219	31.9011
Launch_Month	120.4500	19.8545
Product_Group	110.5931	20.8723
Create_CalMonth	86.3525	13.2233
Price_Index	71.7160	13.7345
Product_Age	64.0715	31.5222
Lead_Time	55.6667	7.8584
		0.0930

Score Inputs



Score Outputs





Scoring API

Scoring API:

```
POST /dataMining/projects/44582f1e-16d7-40d1-a5e4-88366d35e511/models/af352ed7-675d-43d9-a9dc-f5db8b5bb18d/scoreExecutions
Accept: application/vnd.sas.score.execution+json
Content-Type: application/vnd.sas.analytics.data.mining.model.score.request+json
{
  "dataTableUri": "/dataTables/dataSources/cas-fs-cas-shared-default-fs-CASUSER/tables/_VA_FC REVIEW_30957FB9-92CC-46B7-99AF-2371CC6CE01F_GE40",
  "outputCasLibName": "",
  "outputTableName": ""
}
```

Authorization: bearer

```
eyJhbGciOiJSUzI1NiIsImtpZCI6ImxlZ2FjeS10b2tib1rZXkiLCJ0eXAiOiJKV1QiJQ.eyJqdGkiOiI4NmFiNzA4Mzg2ZG10ZTY4YTMwYjhjZTdjOTdmODE2ZilsInN1Yil6lmUzMjE4NjlwLW
UsZwETNDYwOC1hYzRILWU3NTc1NDg1ZjA1MClsInNb3Bljpblm9wZW5pZC1slm1hcmtldGluZylslnBU0FkbWluaXN0cmF0b3Jzll0slmNsawWudf9pZC16nNhcy5kYXRhTWLuaW5
nlwiY2lklijoc2FzLmRhdGFNaW5pbmcilCJhenAiOijzYXMuZGF0YU1pbmluZylslnmdyYW50X3R5cGUoijwYXNzd29yZC1slnVzZXJfaWQiojIMzlxDYyMC1IM2vLTQ2MDgtYWM
0ZS1InzU3NTQ4NWYwNTAiLCJleHRfaWQoij1aWQ9c2FzZGVtbzAxLG91PXVzZXJzLGRjPXZpeWEzMyxkYz1jb20iLCJvcmlnaW4;OjsZGFwliwidXNlcl9uYW1lljocic2FzZGVtbzAxliw
iZw1hWwiOjzYXNkZW1vMDFAZGfjaC12aXlhMzMtc21wLnZpeWEzMy5zYXMuY29tiwiwmV2X3NpZy16lg0MTA1OTUyliaWF0ljoxNT15MjQ2OTA5LCJleHaiOje1MjkyOTAxMD
kslmlzcyl6lmh0dHA6Ly9sb2NhbGhv3QvU0FTG9nb24vb2F1dGgvG9rZW4iLCJ6aWQoij1YWEiLCJhdWQoIolsic2FzLioiLCJvcGVuaWQoLCJzYXMuZGF0YU1pbmluZyJdfQ.ols9
MBMh7Lja0TCyYj7_r03lsvbqlfTdpT3fotQpyTKYogMgx0lFNFrOwe4QlRYwnPiDpC7L3dal2GrF_vHrP-KW0tf-
2lnr6FDJXBFDvQPYETn7i0E7NYMGS0a4HGSSPbeUwAvdfwf5gUltSiFnD9yWrrJnEv-ypYhTUheZ0
```

Download Type:

REST

SAS

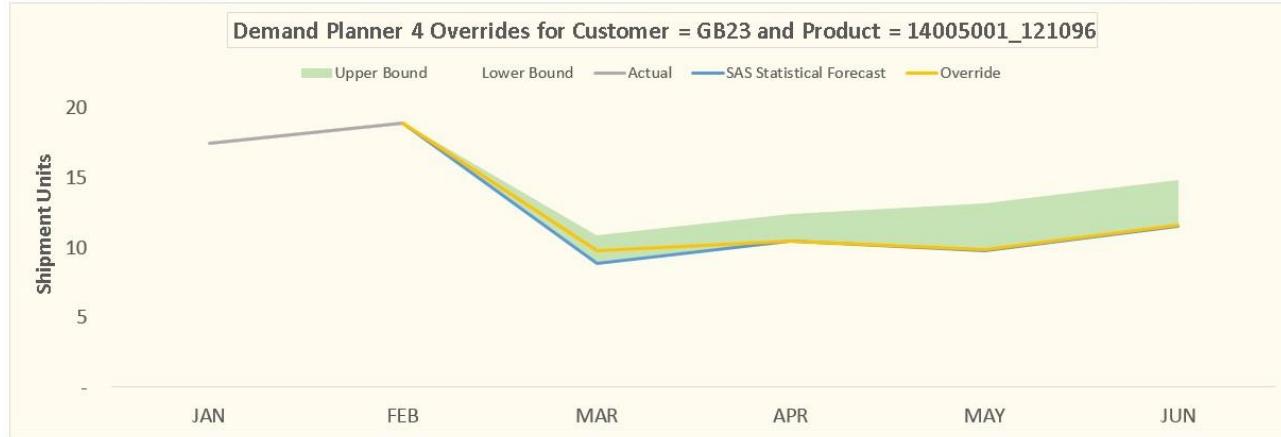
Python

REST

Applying the Recommendations in the Planning Process



Planner Overrides



- ✓ Override direction
- ✓ Range of the overrides

Select the Customer/Product to View or Override:

Planner ... Demand Planner 4
Customer ... GB23
Product ... 14005001_121096

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	History	History	Current	Future								
Actual	17.48	18.90	-	-	-	-	-	-	-	-	-	-
SAS Statistical Forecast			8.83	10.48	9.73	11.50	-	-	-	-	-	-
Recommended Adj Direction	-	-	▲	▲	▲	▲	-	-	-	-	-	-
Override			9.78	10.48	9.87	11.60	-	-	-	-	-	-
Lower Bound	17.48	18.90	8.83	10.48	9.73	11.50	-	-	-	-	-	-
Upper Bound	17.48	18.90	10.85	12.42	13.17	14.83	-	-	-	-	-	-

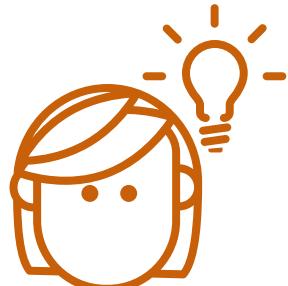
Override Legend:

Value entered is out of recommended bounds
Recommend an override
No override recommended

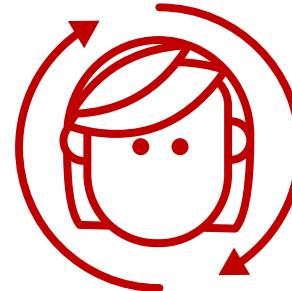
Different Persona Groups in our Case Study



Demand Planner



Demand Analyst



Data Scientist



IT / Automation

Using SAS Procedures to prepare and analyze data on the CAS Server (distributed/In-Memory)

```
/** Create a partition variable with 70% in Train Data ***/  
proc partition data=cas1.fc_review seed= 15 partind sampct=70;  
  output out=cas1.fc_review copyvars=(_all_);  
run;
```

Using the GRADBOOST procedure

```
28 proc gradboost data=cas1.fc_review  
29   earlystop(tolerance=0 stagnation=5)  
30   numBin=20 binmethod=BUCKET  
31   maxdepth=6  
32   maxbranch=2  
33   minleafsize=5  
34   assignmissing=USEINSEARCH minuseinsearch=1  
35   seed=12345  
36   printtarget  
37 ;  
38 partition rolevar=_partind_ (TRAIN='1' VALIDATE='0');  
39 autotune useparameters=CUSTOM tuningparameters=(  
40   lasso(LB=0 UB=10 INIT=0)  
41   learningrate(LB=0.01 UB=1 INIT=0.1)  
42   ntrees(LB=20 UB=150 INIT=100)  
43   ridge(LB=0 UB=10 INIT=0)  
44   samplingrate(LB=0.1 UB=1 INIT=0.5)  
45   vars_to_try(LB=1 UB=7 INIT=7)  
46 )  
47 searchmethod=GA objective=KS maxtime=900  
48 maxevals=50 maxiters=5 popsize=10  
49 targetevent='1'  
50 ;
```

Using the GRADBOOST procedure (cont.)

```
target FVA_Ind / level=nominal;
input FC_Change Lead_Time Price_Index Product_Age / level=interval;
input Model Product_Group Target_CalMonth / level=nominal;

ods output
    VariableImportance    = sasdata.FVAGrdBst_VarImp
    Fitstatistics         = sasdata.FVAGrdBst_outfit_autotune0
    PredProbName          = sasdata.FVAGrdBst_PredProbName
    PredIntoName          = sasdata.FVAGrdBst_PredIntoName
    TunerResults          = sasdata.FVAGrdBst_tuneresults
    BestConfiguration     = sasdata.FVAGrdBst_tunebest(drop=name)
;
savestate rstore=cas1.FVAGrdBst_Astore;
run;
```

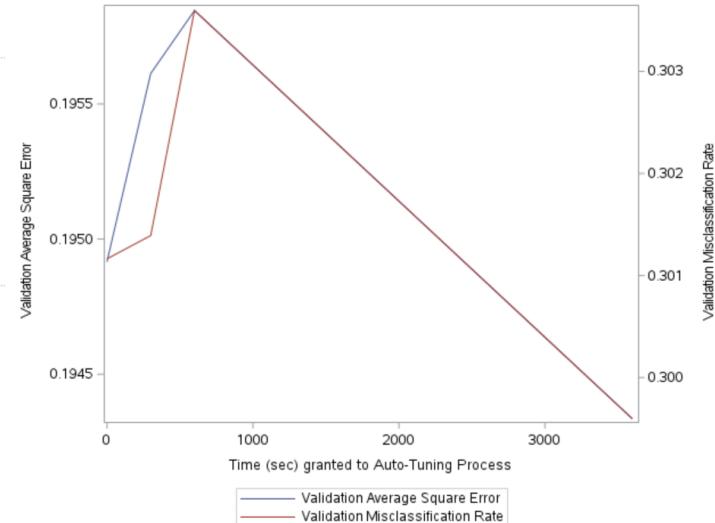
Analyse Results from different Runs with SAS Code

```
data sasdata.FVA_ValidASE;
set sasdata.FVAGrdBst_outfit_autotune:
  ind$name=autotune_time;
autotune_sec = input(compress(autotune_time,, "dk"),8.); *** dk = digits + keep them;
run;
```

```
proc sort data=sasdata.FVA_ValidASE;
by autotune_sec;
run;
```

```
data sasdata.FVA_ValidASE;
set sasdata.FVA_ValidASE;
by autotune_sec;
if last.autotune_sec then output;
run;
```

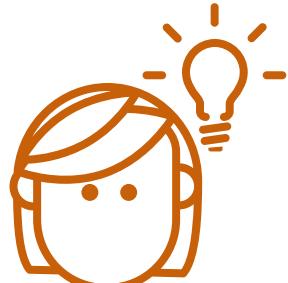
```
proc sgplot data=sasdata.FVA_ValidASE;
series x=autotune_sec y=asevalid;
series x=autotune_sec y=miscvalid / y2axis;
xaxis label = "Time (sec) granted to Auto-Tuning Process";
run;
```



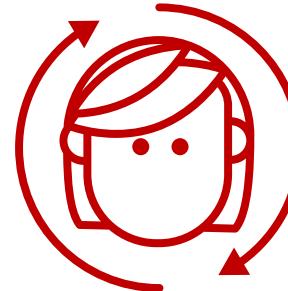
Different Persona Groups in our Case Study



Demand Planner



Demand Analyst



Data Scientist



Open Source
Data Scientist



IT / Automation

Working from the Jupyter Notebook Using the SWAT-Package of SAS

```
from swat.render import render_html
from swat import *
from pprint import pprint

import matplotlib.pyplot as plt
import pandas as pd
from pandas import*
import numpy as np

import seaborn as sns
get_ipython().magic('matplotlib inline')
from IPython.core.interactiveshell import InteractiveShell
InteractiveShell.ast_node_interactivity = "all"

In [2]: # Provide Connection Information and Upload Data if not yet available

cashost='dach-viya33-smp.viya33.sas.com'
casport=5570
casauth='~/.authinfo'
indata_dir="/opt/demodata/sasdata"
indata="new_product_train"
table=indata_dir+"/"+indata+".sas7bdat"
shot_df=pd.read_sas(table)

# Create Demo Instance SAS Club and Load Actions Sets for Decision Trees
SASClub = CAS(cashost, casport, authinfo="~/.authinfo", caslib="casuser")

SASClub.loadactionset(actionset="decisionTree")

if not SASClub.table.tableExists(table=indata).exists:
    tbl = SASClub.upload_file(indata_dir+"/"+indata+".sas7bdat", casout={"name":indata})

NOTE: Added action set 'decisionTree'.
```

SAS 9.4 and SAS Viya 3.4 Programming Documentation

(Gerhards favorite website in 2018 😊), Link → @gsvolba tweet on Sept18th

The screenshot shows the navigation bar at the top with links for "SAS® 9.4 and SAS® Viya® 3.4 Programming Documentation / SAS Programming Documentation", a search icon, and PDF/EPUB download links. On the left is a vertical sidebar with a list of topics like "What's New", "Syntax Quick Links", "Data Access", etc. The main content area is divided into three columns. The left column contains "Syntax - Quick Links" (Procedures, CAS Actions, Language Elements) and "What's New". The middle column contains "SAS Procedures" (Base SAS, High Performance, SAS Analytics, Macro Programming) and "Macro Programming". The right column contains "DATA Step Programming" and "DS2 Programming". Each section lists various sub-topics.

SAS® 9.4 and SAS® Viya® 3.4 Programming Documentation / SAS Programming Documentation

What's New

Syntax Quick Links

Data Access

SAS 14.3 Analytics

Base SAS Procedures

DATA Step Programming

Global Statements

System Options

DS2 Programming

FedSQL Programming

Macro Language Reference

Output and Graphics

Operating Environments

Moving and Accessing SAS Files

Encryption

In-Database Technology

Metadata

Syntax - Quick Links

Procedures

- By Name
- By Product
- SAS Viya Procedures

CAS Actions

- Actions by Name
- Action Sets by Name
- Action Sets by Product

Language Elements

- All
- Functions
- CALL Routines
- Statements
- Formats
- Informats
- System Options
- Graphics Options
- Macro Statements

What's New

- What's New in Base SAS 9.4
- What's New in SAS 9.4 and SAS Viya
- SAS Guide to Software Updates

SAS Procedures

Base SAS

- Procedures Guide
- Statistical Procedures
- National Language Support
- ODS
- SQL
- PROC CDISC
- For Windows, UNIX, and z/OS

High Performance

- Base SAS
- SAS Text Miner
- SAS Enterprise Miner
- SAS Forecast Server

SAS Analytics

- SAS/STAT
- SAS/QC
- SAS/OR
- SAS/IML
- SAS/ETS
- PROC OPTGRAPH

Macro Programming

DATA Step Programming

DATA Step Statements

Global Statements

Component Objects

National Language Support

ODS Statements

SAS Logging Facility

DATA Step Debugger and Utility Macros

For Windows, UNIX, and z/OS

For SAS Cloud Analytic Services

Global Statements and Options

Global Statements

SAS System Options

Encryption in SAS

For Windows, UNIX, and z/OS

DS2 Programming

Language Reference

Programmer's Guide

Action Set Syntax in CASL, R, Python, Lua

SAS® 9.4 and SAS® Viya® 3.4 Programming Documentation / SAS Visual Data Mining and Machine Learning Programming Guide

Version ▾

Autotune Action Set: Syntax

Provides actions to tune machine learning algorithm hyperparameters

Syntax Details Examples

tuneGradientBoostTree Action

Automatically adjusts gradient boosting tree parameters to tune a model for minimum error.

Python Syntax

```
results= s.autotune.tuneGradientBoostTree(  
    earlyStop=True | False,  
    scoreOptions="key-1":{any-list-or-data-type-1} <, "key-2":{any-list-or-data-type-2}, ...>,  
    trainOptions={"key-1":{any-list-or-data-type-1} <, "key-2":{any-list-or-data-type-2}, ...>},  
    tunerOptions={  
        "evaluationHistory":True | False,  
        "logLevel":integer,  
        "maxBayesianModelSize":integer,  
        "maxEvals":integer,  
        "maxIter":integer,  
        "maxTime":double,  
        "maxTrainTime":64-bit-integer,  
        "nCrossValFolds":integer,  
        "nParallel":integer,  
        "nSubsessionWorkers":integer,  
    }  
)
```

SAS visual Statistics Programming Guide

SAS Visual Data Mining and Machine Learning Programming Guide

Analytic Store Scoring Action Set

Association Rule Mining Action Set

Audio Action Set

Autotune Action Set

Syntax

tuneBnet Action

tuneDecisionTree Action

tuneFactMac Action

tuneForest Action

tuneGradientBoostTree Action

tuneNeuralNet Action

tuneSvm Action

CASL Lua Python R

Feedback

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```
# Prepare Lists of Variable Names as Python Objects
IntervalVars = ["Product_Age", "FC_Change", "Price_Index", "Launch_Year"]
CategoricalVars = ["Product_Group", "Model", "Target_CalMonth"]
All_Inputs = IntervalVars + CategoricalVars

FVATable = SASClub.CASTable(indata)
FVATable.distinct()
```

§ Distinct

Distinct Counts for FC REVIEW

	Column	NDistinct	NMiss	Trunc
0	FC_ID	423347.0	0.0	0.0
1	ID	6085.0	0.0	0.0
2	Target_Month	84.0	0.0	0.0
3	Create_Month	84.0	0.0	0.0
4	StatFC	13455.0	0.0	0.0

In [10]:

```
FVATable.freq(inputs=CategoricalVars)
```

Out[10]: § Frequency

Frequency for FC REVIEW

	Column	NumVar	CharVar	FmtVar	Level	Frequency
0	Product_Group	2.0			2	1 21908.0
1	Product_Group	3.0			3	2 233177.0
2	Product_Group	4.0			4	3 1353.0
3	Product_Group	5.0			5	4 9791.0
4	Product_Group	6.0			6	5 18681.0
5	Product_Group	7.0			7	6 22.0
6	Product_Group	8.0			8	7 65474.0

In [13]: # Alternative
FVATable[CategoricalVars].freq()

Out[13]: § Frequency

Frequency for FC REVIEW

	Column	NumVar	CharVar	FmtVar	Level	Frequency
0	Product_Group	2.0		2	1	21908.0
1	Product_Group	3.0		3	2	233177.0
2	Product_Group	4.0		4	3	1353.0
3	Product_Group	5.0		5	4	9791.0
4	Product_Group	6.0		6	5	18681.0
5	Product_Group	7.0		7	6	22.0
6	Product_Group	8.0		8	7	65474.0
7	Product_Group	9.0		9	8	20915.0
8	Product_Group	10.0		10	9	280.0

Working from the Jupyter Notebook (cont.)

Creating SAS Scorecode from the Jupyter Notebook (cont.)

```
In [5]: # Train a Random Forest  
# to see the most important attributes
```

```
Forest1 = SASClub.decisionTree.forestTrain(  
    table={"name":indata, },  
    inputs=All_Inputs,  
    nominals=CategoricalVars,  
    target="Quantity",  
    copyVars=All_Inputs,  
    nTree=100,  
    nBins=10,  
    leafSize=100,  
    maxLevel=21,  
    crit="GAINRATIO",  
    varImp=True,  
    missing="USEINSEARCH",  
    vote="prob",  
    OOB=True,  
    casOut={"name":"forest_model", "replace":True}  
)
```

```
In [6]: # Display ModelInformation and Variable Importance List  
  
Forest1.ModelInfo  
Forest1.DTreeVarImpInfo
```

Out [6]:

Forest for NEW_PRODUCT_TRAIN

	Descr	Value
0	Number of Trees	1.000000e+02
1	Number of Selected Variables (M)	4.000000e+00
2	Random Number Seed	0.000000e+00
3	Bootstrap Percentage (%)	6.321206e+01
4	Number of Bins	1.000000e+01
5	Number of Variables	1.000000e+01

```
ScoreCode = SASClub.decisionTree.forestCode(modelTable={"name":"forest_model"} )
```

```
ScoreCode
```

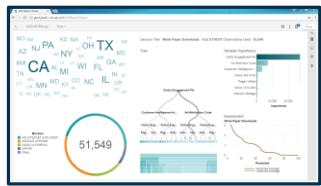
Out [53]: § CodeGen

Generates SAS Code from Modeling Task for Table
FOREST_MODEL

	SASCode
0	length _strfmt_ \$14; drop _strfmt_\n_strfmt_ ...
1	_node_id_ = 0;\n_new_id_ = -1;\nnextnode_tre...
2	_new_id_ = 1;nend;\nelse if (_numval_ ge -500...
3	_new_id_ = 2;nend;\nend;\nelse if _node_id_ e...
4	else if (_numval_ ge 1980 and _numval_ lt 2012...
5	else if _node_id_ eq 2 then do;\n_numval_ = FC...
6	_new_id_ = 6;nend;\nelse if (_numval_ lt -500...
7	else if _node_id_ eq 3 then do;\n_strfmt_ = le...
8	_new_id_ = 8;nend;\nend;\nelse if _node_id_ e...
9	_strfmt_ = left(trim(put(Product_Group,BEST12....
299928	_sumx2_ + (-34.1682468)*(-34.1682468); \n_i...
299929	_sumx2_ + (-15.10797883)*(-15.10797883); \n_i...
299930	_sumx2_ + (-5.054346851)*(-5.054346851); \n_i...
299931	_sumx2_ + (-7.512762961)*(-7.512762961); \n_i...
299932	_sumx2_ + (-3.311956891)*(-3.311956891); \n_i...
299933	_sumx2_ + (-5.662335842)*(-5.662335842); \n_i...
299934	_sumx2_ + (-3.035977027)*(-3.035977027); \n_i...
299935	_sumx2_ + (-6.233139721)*(-6.233139721); \n_i...
299936	_sumx2_ + (-10.19797534)*(-10.19797534); \n_i...

Openness of the SAS Platform

Visual Interfaces



Programming Interfaces



API Interfaces



Demand
Planner

Demand
Analyst



Data Scientist



SAS Coder

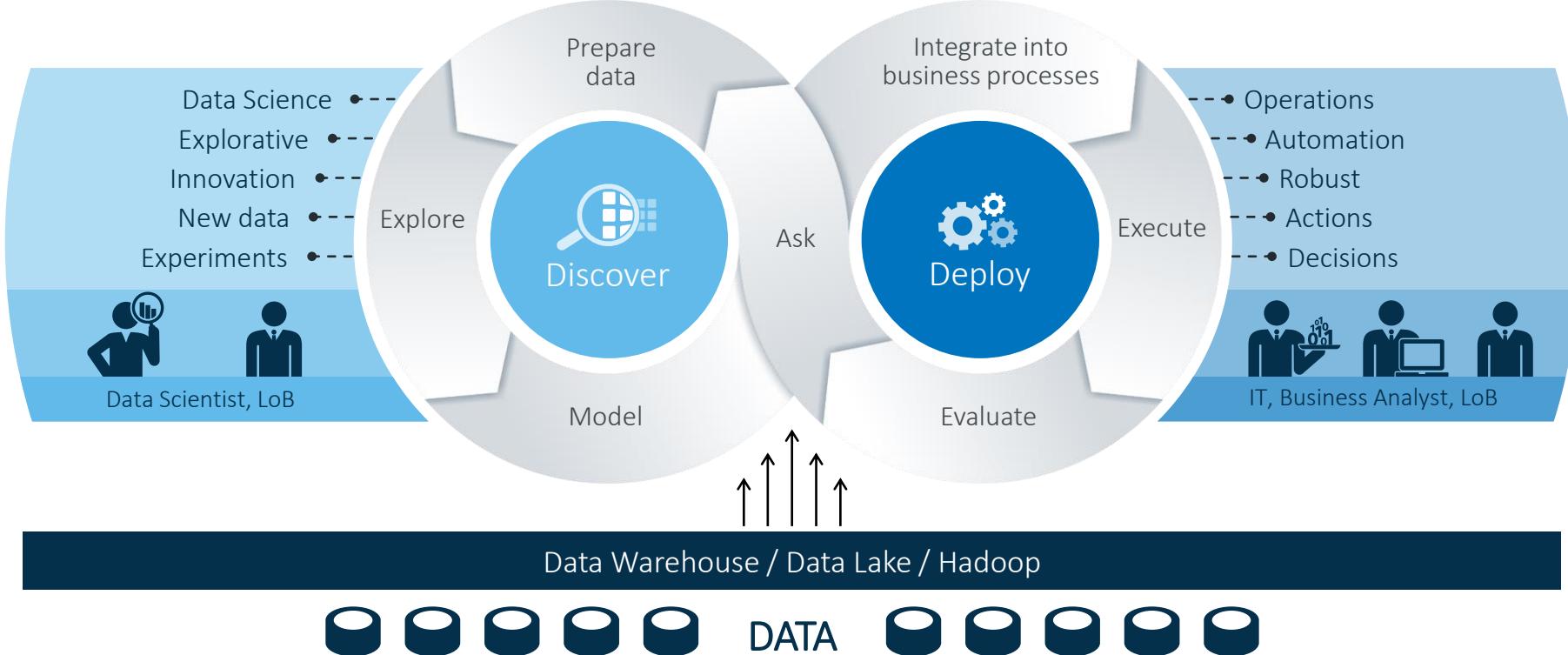
Open Source
Coder

IT / Automation



Managing the Analytical Life Cycle with SAS

Building the bridge between discovery and moving analytical results into production



The SAS Viya® Home Screen

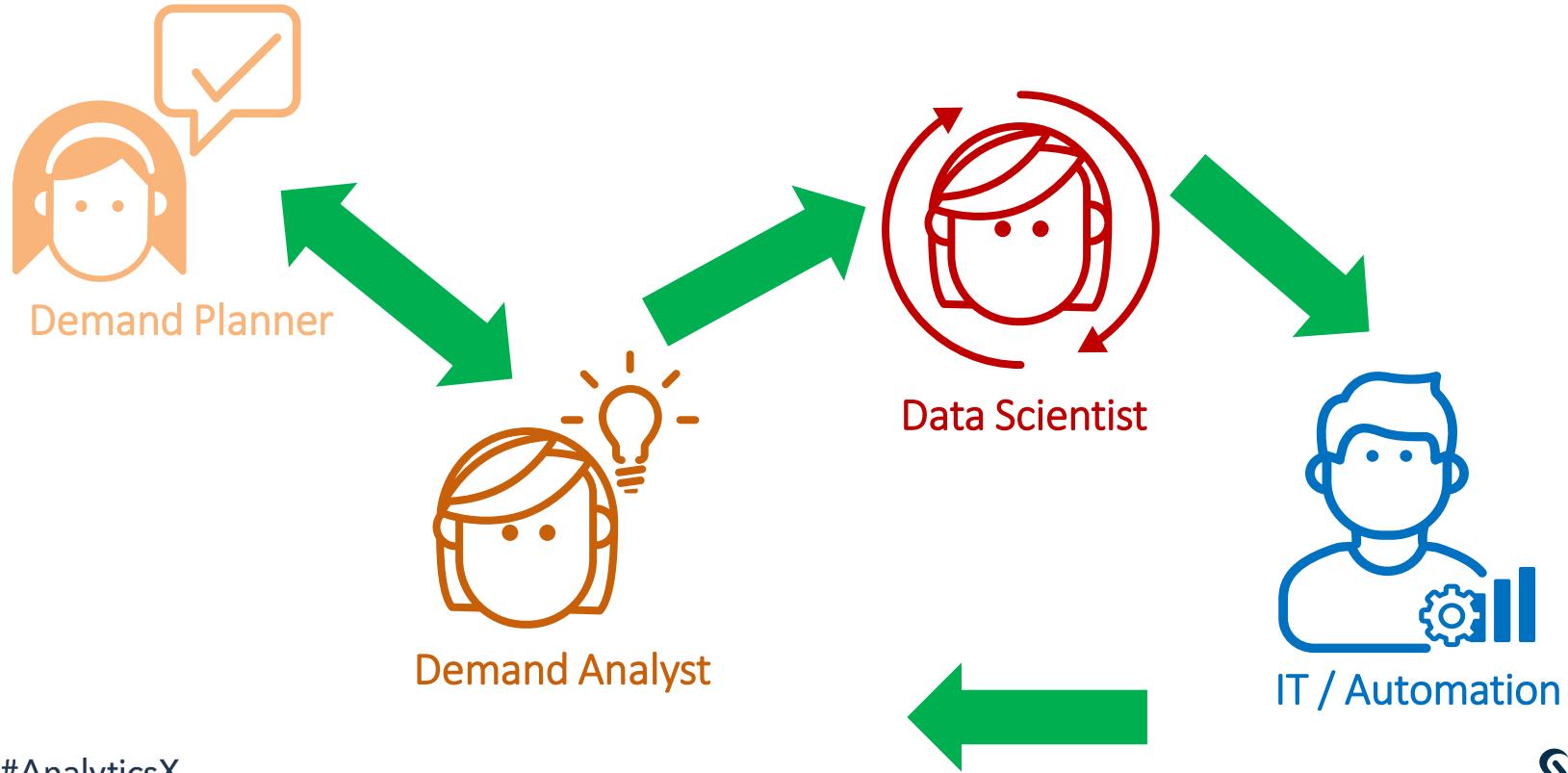
The screenshot displays the SAS Viya Home Screen interface. At the top, there is a dark blue header bar with the title "SAS® Home" on the left and a "Search" input field on the right. Below the header, a navigation bar contains three buttons: "Browse" (with a folder icon), "Shortcut" (with a plus icon), and "Tile" (with a plus icon). The main content area is organized into several sections:

- Manage Data** (Green button)
- Explore and Visualize Data** (Yellow button)
- Build Models** (Orange button)
- Manage Models** (Red button)
- Manage Workflows** (Blue button)
- Manage Environment** (Blue button)

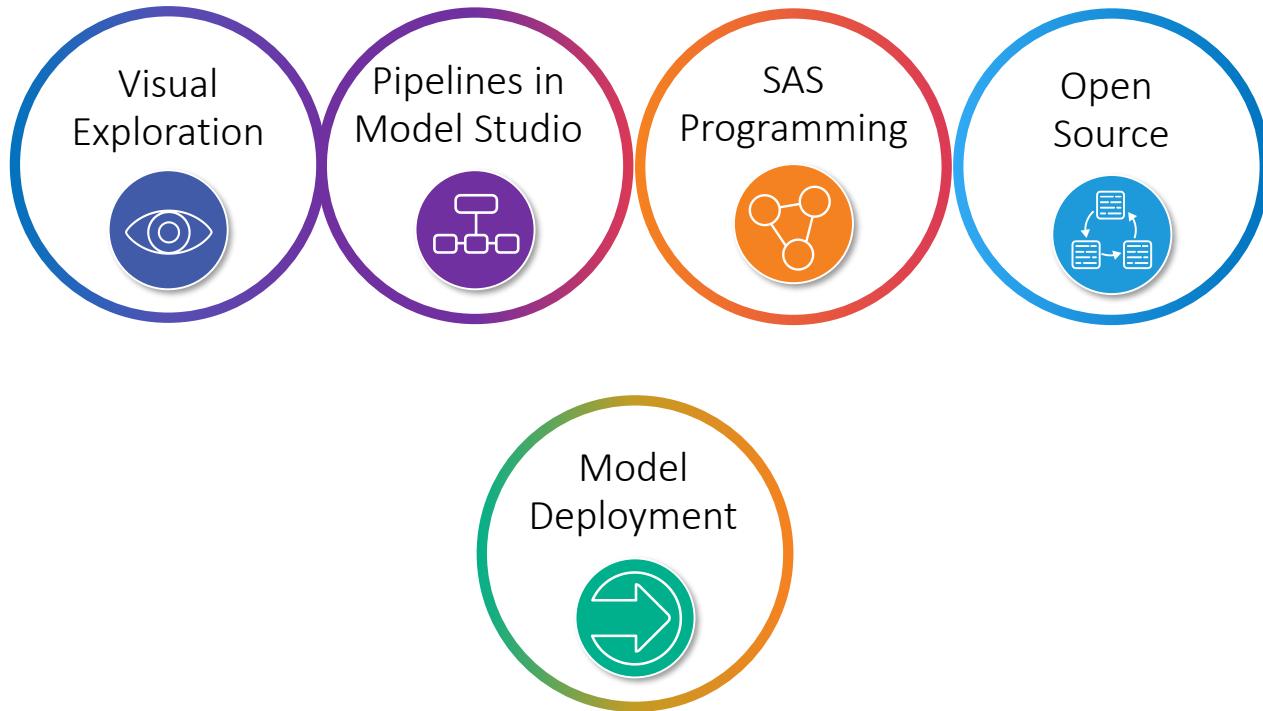
Below these buttons are three larger sections:

- Recent**: A list of recent items, each with a small icon, a name, a date, and an information icon.
 - New_Product_V1 (May 11, 2018 10:12:49.90 AM)
 - FC_Review_V1 (May 11, 2018 09:10:53.29 AM)
 - Product_Base_0 (May 9, 2018 07:46:38.90 PM)
 - Demo0_Cars (May 4, 2018 02:48:27.32 PM)
- Favorites**: A list of favorite items, each with a small icon, a name, a type, and an information icon.
 - FC_Review_V1 (Report)
 - New_Product_V1 (Report)
- Links**: A list of external links, each with a name and an information icon.
 - [SAS Studio](#)
 - [Python Jupyter Notebook](#)
 - [R-Studio](#)

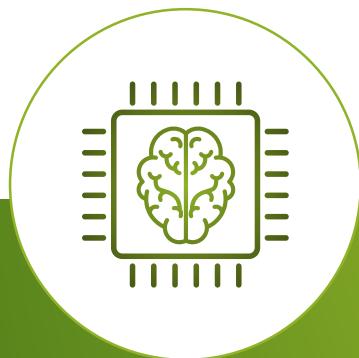
SAS Viya facilitates the handshake between different user personas in the analysis process



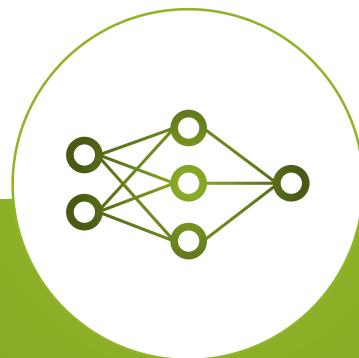
Ways to Interact with the SAS Analytic Platform



Key Investment Areas von SAS



Artificial Intelligence



Analytics Everywhere



Analytics for Everyone